LIQUID CARBON SOURCES FOR DEPOSITION OF NANOSTRUCTURAL DIAMOND

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Abstract

Nanostructural diamond particles were obtained by hot filament CVD methods from vapor of liquid carbon sources and hydrogen-rich atmosphere on Si and Al_2O_3 ceramics substrates with different reaction times. During the studying the relation of gases and total pressure was changed. SEM and Raman spectrum demonstrated the diamond nature of obtained "cauliflower-like" particles.

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In this work it is reported about nanostructural diamond deposition by hot filament chemical-vapor deposition method. The vapor of liquid acetone, butyl alcohol and ethanol were used as carbon sources. Nanostructural diamond was deposited on substrates of silicon and Al_2O_3 ceramics. Technological parameters of deposition are presented in Table 1. The influence of liquid carbon sources, substrates, reaction times, pressure ratios of hydrogen and vapor of carbon source, and total pressure on the results of deposition was studied in this work.

Table 1. Technological conditions nanodiamond deposition.

Substrate type	Al_2O_3	Si	Si	Si	Si	Si	Si
Distance filament-substrate, mm	2	2.5	2.5	2.5	2.5	2.5	2.5
Reaction time, min	30	7; 10	10	15	7	7	5; 7; 10; 30
Filament temperature, ^{0}C	2300	2300	2300	2300	2300	2300	2300
Substrate temperature, ^{0}C	700	780	780	780	780	780	780
Hydrogen pressure, Torr	294	595	597	600	472	531	590
Acetone pressure, Torr	6	-	-	-	8	9	10
Butyl alcohol pressure, Torr	-	5	3	-	-	-	-
Ethanol pressure, Torr	-	-	-	10	-	-	-
Total pressure, Torr	300	600	600	610	480	540	600

The diamond particles were characterized with field-emission scanning electron microscopy (SEM) and micro-Raman spectroscopy. The results of some samples are presented on the figure 1, and figure 2. Raman spectrum exhibits a first-order diamond peak centered at 1330-1332 cm^{-1}. For all samples it was observed the wide signals in the range at 1400-1600 cm^{-1} that certify graphite presence during the deposition process. SEM images of obtained diamond particles are similar the results reported in work [1, 2, 3] and by the same way can be characterized as "Cauliflower-like". Our cauliflower-like diamond particles were deposited for both substrate types and from all carbon liquid sources. From SEM it is seen that size of diamond particles formed cauliflower particles varies from 70 nm to 1.4 μm for process running 30 min. But during experiment it was found that reaction time has the big influence on the size of grown particles even for our case when the longest deposition time makes up only 30 min. It means that size of diamond particles deposited under shorter time was smaller and we observe the nanodiamond with size of 30-50 nm. We don't observe the dependence of shape of cauliflower-like particles from type of carbon liquid source.

The dependence of nanostructural diamond particle size on total pressure indicates that decreasing of total pressure leads to reduction of cauliflower-like diamond size and consequently to decreasing of size of particle formed it. It is difficult also to make a clear conclusion about influence of pressure relation between hydrogen and vapor of liquid carbon source, because their variation was not in wide area. One from the most interesting result obtained in this investigation is that nanostructural diamond was deposited in hydrogen-rich atmosphere without argon whose huge role was reported in many reports [1,4,5].

Thus it was found on present research that technological conditions allowed depositing nanostructural diamond from liquid carbon sources of different types on Si and Al_2O_3 substrates in hydrogen-rich atmosphere without Ar. This is a new result enhanced our knowledge about posibility of nanomaterial synthesis.

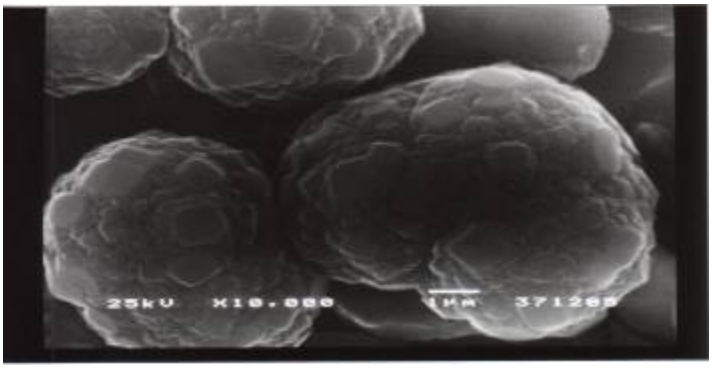

Figure1. SEM image of nanostructural diamond deposited on Al_2O_3 substrate for 30 min from acetone.

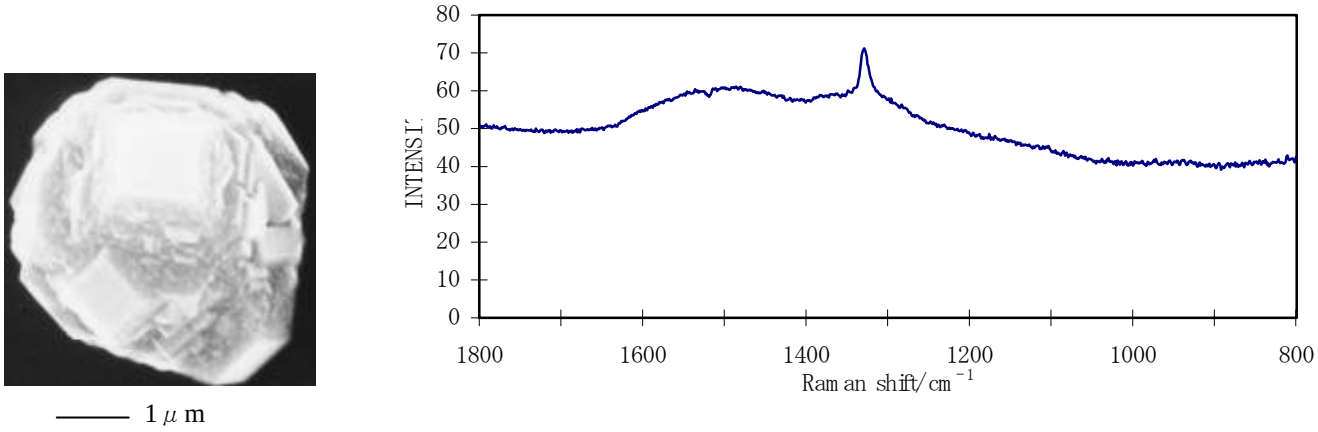

Figure 2. SEM and Raman for nanostructural diamond deposited on Si substrate for 10 min from acetone.

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